Chapter V

VE METHODOLOGY PART I: GENERATING PROPOSALS

Introduction

A task which is accomplished in a planned and systematic reamer is more likely to be productive than one which is unplanned and relies upon undisciplined ingenuity. VE efforts generally follow a variation of the scientific method to assure a planned purposeful approach. This procedure is termed the VE Job Plan. It was conceived as a group undertaking because it is unlikely that an implemented VE proposal will be the product of the effort of a single individual. This chapter explains the VE Job Plan as it would be employed in a specific VE study.

Group Dynamics

The cornerstone of an effective VE effort is the generation of a large number of useful ideas developed into feasible proposals. To accomplish this efficiently, it is common practice to seek and utilize contributions from specialists representing many disciplines and form a team amalgamating their specialties with VE. Those team members who are VE specialists provide motivation and guidance to assure that the VE Job Plan is followed. The other specialists are used to gain new insight and generate new ideas. They not only contribute their own capabilities but also usually have ready access to additional specialists. Although it is not necessary for all team members to have had previous VE training, it is a desirable goal. Each member of the team contributes a pattern of thinking which is characteristic of his or her specialty and experience. Each member tends to stimulate other team members to contribute their characteristic patterns of thinking. Each can determine and discuss the effect another's idea will have on his or her own area of interest.

No single phase of the VE Job Plan should be assigned as a secondary responsibility on a part-time basis with the expectation that collectively VE will be accomplished. Experience has proven that a VE effort is most productive when all personnel involved in the team actively participate in all phases of the VE Job Plan.

The group dynamics of a VE team effort produce benefits which the efforts of one or two individuals can seldom match. Among the prominent benefits are:

- More talent is directly applied to the problem.
- The scope and depth of the effort is increased.
- More efficient use is made of the available time because problem areas are more readily resolved through direct communications.
- Team participation provides productive training for those not previously exposed to formal VE training and serves as a refresher course for those with previous VE training.
- The synergistic effect of a diverse group working in harmony toward a common objective.

The VE Job Plan

Several versions of the VE Job Plan can be found in current VE literature. Some texts list five phases, others six, and some refer to more. However, the number of phases is less important than-the systematic approach implied. This manual describes a seven-phase VE Job Plan. It encompasses the same fundamentals contained in other VE Job Plans (Figure V-l). Actually, there are no sharp lines of distinction between the phases. They tend to overlap in varying degrees and generally require several iterations through many of the phases of the plan.

An effective VE effort must include all phases of the Job Plan. However, the proper share of attention given to each phase may differ from one effort to another. The Job Plan represents a concerted effort to furnish the best answers to the following "key questions':

What is it?
What does it do?
What must it do?
What does it cost?
What is it worth?
What else might do the job? ,
What does that cost?
What will satisfy all of the users' needs?
What is needed to implement it?

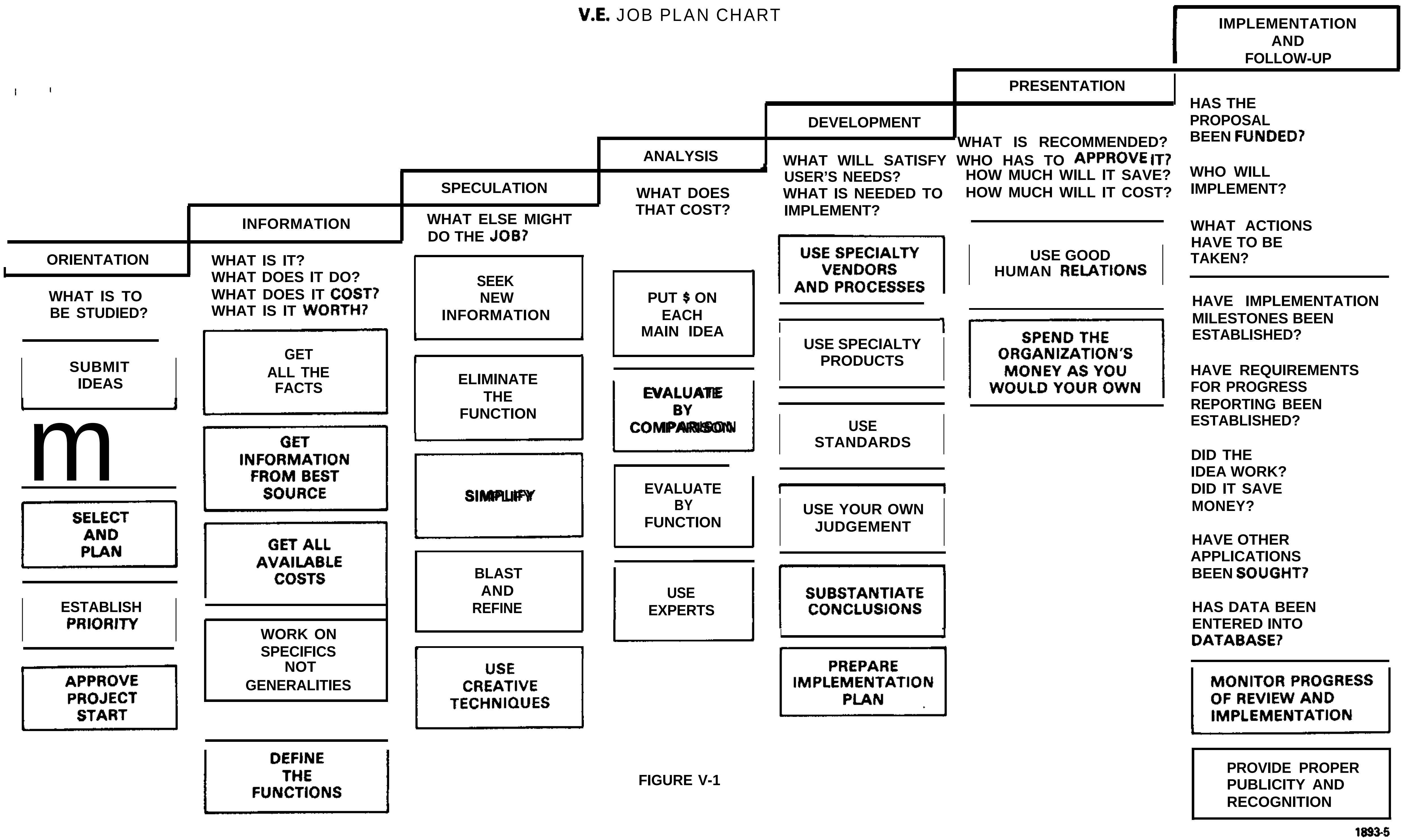
V.E. JOB PLAN CHART
ORIENTATION
WHAT IS TO BE STUDIED?
SUBMIT IDEAS
SELECT AND PLAN
ESTABLISH PRIORITY
APPROVE PROJECT START
INFORMATION
WHAT IS IT?
WHAT DOES IT DO?
WHAT DOES IT COST?
WHAT IS IT WORTH?
GET ALL THE FACTS
GET INFORMATION FROM BEST SOURCE
GET ALL AVAILABLE COSTS
WORK ON SPECIFICS NOT GENERALITIES
DEFINE THE FUNCTIONS
SPECULATION
WHAT ELSE MIGHT DO THE JOB?
SEEK NEW INFORMATION
ELIMINATE THE FUNCTION
SIMPLIFY
BLAST AND REFINE
USE CREATIVE TECHNIQUES
ANALYSIS
WHAT DOES THAT COST?
PUT $ ON EACH MAIN IDEA
EVALUATE BY COMPARISON
EVALUATE BY FUNCTION
USE EXPERTS
DEVELOPMENT
WHAT WILL SATISFY USER'S NEEDS?
WHAT IS NEEDED TO IMPLEMENT?
USE SPECIALTY VENDORS AND PROCESSES
USE SPECIALTY PRODUCTS
USE STANDARDS
USE YOUR OWN JUDGEMENT
SUBSTANTIATE CONCLUSIONS
PREPARE IMPLEMENTATION PLAN
PRESENTATION
WHAT IS RECOMMENDED?
WHO HAS TO APPROVE IT?
HOW MUCH WILL IT SAVE?
HOW MUCH WILL IT COST?
USE GOOD HUMAN RELATIONS
SPEND THE ORGANIZATION'S MONEY AS YOU WOULD YOUR OWN
IMPLEMENTATION AND FOLLOW-UP
HAS THE PROPOSAL BEEN FUNDED?
WHO WILL IMPLEMENT?
WHAT ACTIONS HAVE TO BE TAKEN?
HAVE IMPLEMENTATION MILESTONES BEEN ESTABLISHED?
HAVE REQUIREMENTS FOR PROGRESS REPORTING BEEN ESTABLISHED?
DID THE IDEA WORK?
DID IT SAVE MONEY?
HAVE OTHER APPLICATIONS BEEN SOUGHT?
HAS DATA BEEN ENTERED INTO DATABASE?
MONITOR PROGRESS OF REVIEW AND IMPLEMENTATION
PROVIDE PROPER PUBLICITY AND RECOGNITION
1893-5

FIGURE V-1

The remainder of this chapter is devoted to describing and discussing the essential elements of the first five phases of the Job Plan as they occur in a typical VE effort. The sixth and seventh phases (Presentation and Implementation and Follow-up) is discussed in the next chapter.

Orientation Phase

The selection of VE projects is a management responsibility in the orientation phase. The success of the VE program depends on management exercising its project authority wisely. Most organizations have limited VE resources available for a large number of projects; therefore, project selection should be based on maximizing return (maximum cost reduction) for the total VE investment. Selections should be ranked by dollar value with the most potential for savings being assigned to the product with the highest total cost. In the early stages of the VE program, the selection process may be quite simple but when the obvious projects are depleted, the need for a systematic project selection procedure develops. Guidelines for the selection of projects may mean little in a specific situation. Due to the wide variety of situations, the VE management approach may be different. Since identifying cost function worth relationships is a way to identify VE opportunities, these techniques can also be used to identify preliminary projects. Throughout the selection process one way to help ensure success is to make sure management is aware of the potential of the VE technique, the capability of VE personnel, and those decisions necessary to fully utilize the available VE resources.

Information Phase

The second phase of the VE Job Plan has these objectives:

- An understanding of the product being studied.
- Determining the essential functions.
- Estimating the potential value improvement.

A. Types of Data

To acquire an adequate understanding of the subject of the VE effort, the product itself must be studied as well as its general technological area. Data accumulated should include the predicted total cost of ownership; the present configuration; the quality, reliability, and maintainability attributes ; the quantity involved; and the development history. Included among the required general information are the current applicable state-of-the-art sources of supply, processes, and procedures, and a listing of individuals whose specialized knowledge might prove useful during the study. It is most important to seek qualified sources to obtain facts, not opinions. All relevent information is important. The data must be supported, either by appropriate documents, or by reference to their source.

B. Functional Analysis

One of the most important elements of the VE Job Plan is the description of the function of an item. It is the foundation upon which the entire effort is based. If incorrect, it can easily mislead the entire effort.

However, it is not unusual for the original functional description to be modified or replaced by a better version as additional insight is gained during the VE study. One trap to avoid is the temptation to base the description of function on the observed characteristics of the existing design. Do not assume that all of the characteristics of the present design are required. It is quite possible that not all of the functions are actually needed to satisfy the user's needs.

The primary objective of functional analysis is to facilitate the discovery of alternative means of achieving the desired performance. It is also one way to identify areas offering likely opportunities for value improvement. Functional descriptions in the simplest specific terms offer the greatest potential for the development of alternatives. <u>This simplicity of expression is accomplished by using only two words: a verb and a noun</u>. The reasons for this restriction in the functional description are:

- To focus on function rather than the item.
- To avoid confusion from combining functions.
- To encourage creativity.
- To free the mind from specific configurations.
- To reveal unnecessary costs.
- To facilitate comparison.

The two word function description results in a clear and concise definition. The verb should be an active verb, e.g., adjust, decrease, hold, etc., to describe an action, occurrence or state of being of the item under study in such a way as to facilitate comparison. The noun should be quantifiable, e.g., current, pressure, weight, etc., for the same reason-

Another characteristic of the function description that is important is the level of abstraction. The level of abstraction may be explored by starting with the verb and noun that comes to mind most readily and asking the questions "how" and "why" and answering them with function statements. Asking "how" lowers the level of abstraction and asking "why" raises the level, making the function description more general. In practice, the desired level is one that makes possible the largest number of feasible alternatives. Since the higher levels are more inclusive, affording more opportunities, what is desired is the highest level that includes applicable, achievable alternatives. A practical limit to the "why" direction is the highest level at which the practitioner is able to make changes.

If the level selected is too low, alternatives may be restricted to those resembling the existing design. If the level is too high, it may suggest alternatives that are beyond the scope of effort and obscure achievable ones.

The-function descriptions for the various parts or features of a product or procedure may be joined to form a diagram that shows the dependency relationship of the functions to each other. The diagram is constructed using the "how" and "why" logic. The apportioning of the total cost to each of the functions makes the diagram, in effect, a function-cost model that facilitates targeting of the VE effort.

Functions are categorized as either basic or secondary. An item's basic function is the function(s) required to provide the essential utility needed by the user. Secondary functions play an enabling role. They merely make the basic function(s) achievable. Secondary functions are considered to make no direct contribution to worth, but do add directly to cost. Consequently, value improvement efforts aim to minimize the number of secondary functions.

The worth of each basic function must be established in order to:

- Determine whether or not the VE effort will be worthwhile.
- Obtain a reference point from which the cost of alternatives can be compared.
- Formulate a target cost or goal, to provide a psychological incentive to discourage a premature relaxation of the VE effort.

When analyzing the functions of a large system, it is common practice to first divide it into major areas. Each area may then be approached (1) as an element in the next larger assembly; (2) in terms of its own components; or (3) as an identifiable, nondivisible item. The relative position that an item occupies in a system or total assembly is called its level of indenture. Systems usually have many such levels. The function of a subassembly may be considered nonessential (secondary) in the light of the basic function of the assembly. However, when studying the subassembly by itself, one assumes its function to be essential (basic). The rule for the functional analysis of a system is to work from the top down. As each level of indenture is reviewed, it is temporarily considered as the top level. If the VE objectives are not achieved at the top level, the next lower level of indenture is studied, and so on through to the lowest level.

After selecting an item, the functional analysis proceeds as follows:

- Divide the item into functional areas suitable for further analysis.
- Continue the breakdown for at least three levels of indenture.
- Working from the top down, determine the function of each element of the breakdown structure.
- Determine whether each function is basic or secondary in relation to the function of the next higher level of the analysis.
- Assign a worth of "O" to secondary functions.
- After the basic functions have been described in their simplest terms-j define the dimensions of the noun. For example, if the function is determined to be "apply force", the units of "force" have to be quantitatively stated; i e., 10 lbs.

- Estimate the worth of the essential function(s). That is the cost of performing the essential function(s) in the simplest, most fundamental way.

- Estimate the present cost of each element of the breakdown.

- Using the information derived in the items above, identify areas having excessively low ratios of worth to cost.

c. Economic Analysis

All VE efforts include some type of economic analysis. The objective largely determines the type and degree of economic analysis undertaken. Economic analysis is used to identify areas of VE opportunity and provide a monetary base from which the economic impact of the effort can be determined. The prerequisite for any economic analysis is reliable and appropriate cost data. At the start of a VE effort, the available cost data may not be sufficiently accurate, sufficiently detailed, or arranged in a manner which facilitates its use. Consequently, the VE effort must include the services of one or more individuals who are skilled in estimating, developing, and analyzing cost data. The cost of the original or present method of performing the function is determined or estimated as carefully and precisely as possible. The accuracy of a cost estimate is dependent upon a number of factors such as:

- The "maturity" of the item.

- The availability of detailed specifications and drawings.

- The availability of historical cost data.

- The time available for preparing the estimate.

For instance, estimates of the cost of items in the conceptual stage are not as precise as those based on completed engineering drawings. Even when drawings exist, the estimate for something that has never been produced is likely to be less accurate than something that has.

When structured in a manner which permits identification of high-cost elements, cost data aid in determining the priority of effort within individual studies. High-cost areas may be indicative of poor value, and therefore are prime candidates for initial investigation. Usually costs are distributed in accordance with Pareto's Law; i.e. , a few areas, "the significant few," (generally 20 percent or less) represent most (80 percent or more) of the cost. Conversely 80 percent of the items, "the insignificant many," represent only 20 percent of total costs. This relationship is illustrated in Figure V-2.

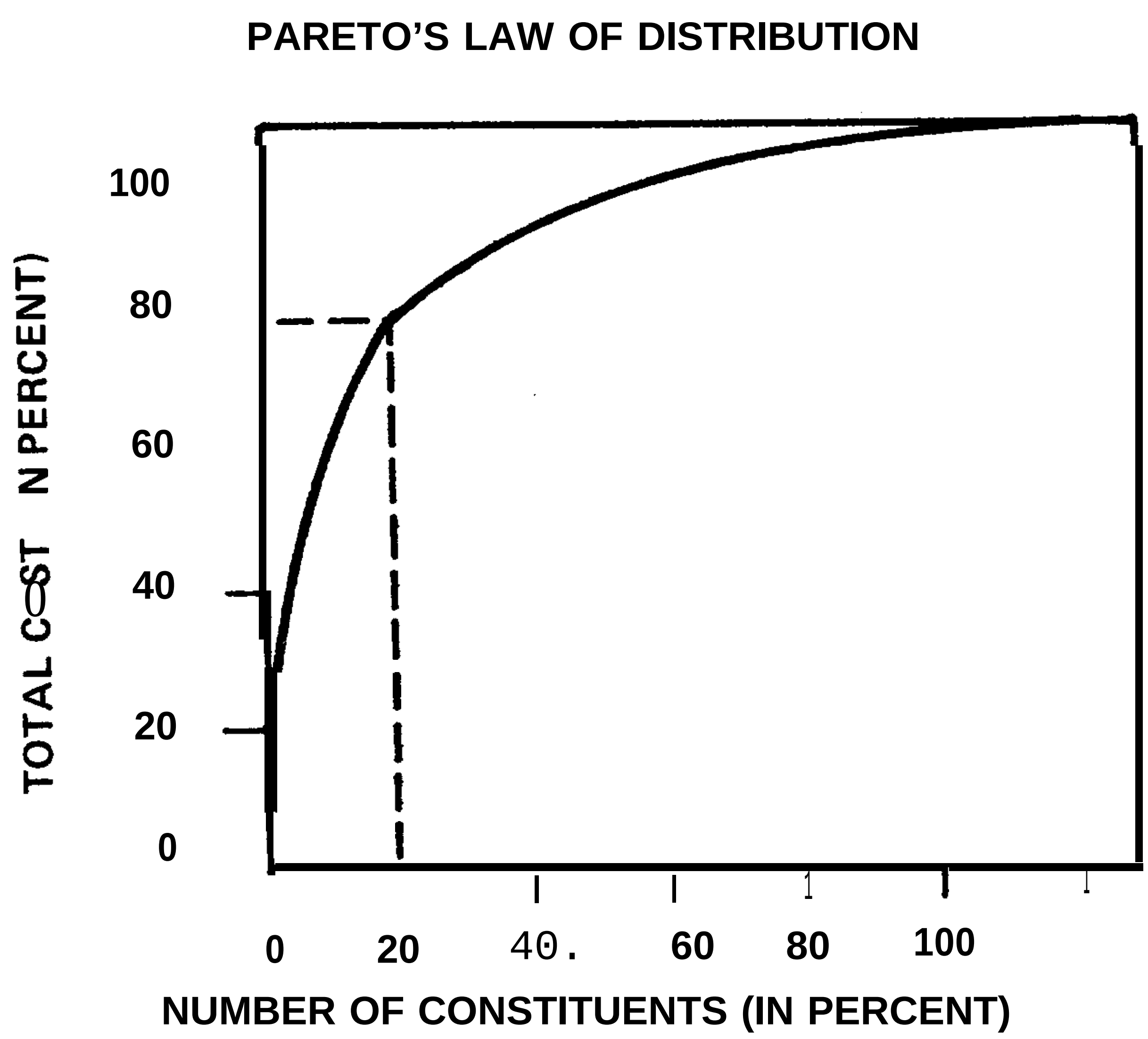
PARETO'S LAW OF DISTRIBUTION
TOTAL COST (IN PERCENT)
100
80
60
40
20
0
0
20
40.
60
80
100
NUMBER OF CONSTITUENTS (IN PERCENT)

FIGURE V-2

One of the most useful economic analysis tools for VE is the cost model which is an expression of the distribution of costs associated with a specific VE effort. Cost models range from those which attempt to portray a breakdown of total cost to those which include only one area of cost, such as" production cost. The extent of the coverage of a cost model is determined by the objective of the VE effort. One form of the cost model is a graphic presentation which is structured similar to an organization chart. Normally a cost model consists only of those cost elements which can be directly affected by VE actions. Dollars already spent ("sunk cost") are usually set apart because they cannot be reduced by the output of a VE effort. Cost elements may be thought of as unit building blocks which can be combined to equal the total cost of the subject of the study. Ideally, cost elements are assigned to each level of indenture within the cost model. For example, if a handbook or manual is the item being studied, costs are assigned to each portion that has been separately identified. Alternatively, it may be desirable to prepare an overall cost model for the manual and then apportion it among the lower levels of indenture.

As a VE study progresses to completion, the cost model is refined. Target costs may be added to the cost model (see Figure V-3) or the entire structure of the cost model may be altered as a result of new information or new insight regarding VE opportunities. The final model may include savings developed during the VE effort as progress is made toward achieving the targets.

Cost models are used in a VE effort to:

- Determine the economic feasibility of a VE study. A cost model highlights the potential for economic improvement. It displays current costs together with target costs. Combined with an estimate of the resources (man-hours, skills, money, etc.), it is a valuable tool for determining the potential return on investment of the VE study.

- Evaluate the necessity for redirecting the effort. The cost model is revised during the VE study to display progress toward the targets. Continued awareness of this progress provides the insight necessary to redirect the study, if necessary, toward more profitable areas in time to gain maximum benefits.

- Extend benefits to other items. Certain functional elements represented on the cost model of a particular item or system may be similar to those of another item or system. Recognition of this similarity can suggest other value improvement opportunities which might otherwise remain unnoticed.

- Determine the net savings opportunity. A comparison of the potential savings displayed in the final cost model with the investment required to implement the VE proposals helps determine the net potential savings and the potential return on investment.

- Review the results. A cost model will highlight areas where the opportunity for economic improvement may not have been fully exploited. Further investigation may reveal the advisability of

COST/VALUE TARGET MODEL
(FUNCTIONAL ELEMENTS OF TACTICAL MICROWAVE EQUIPMENT)

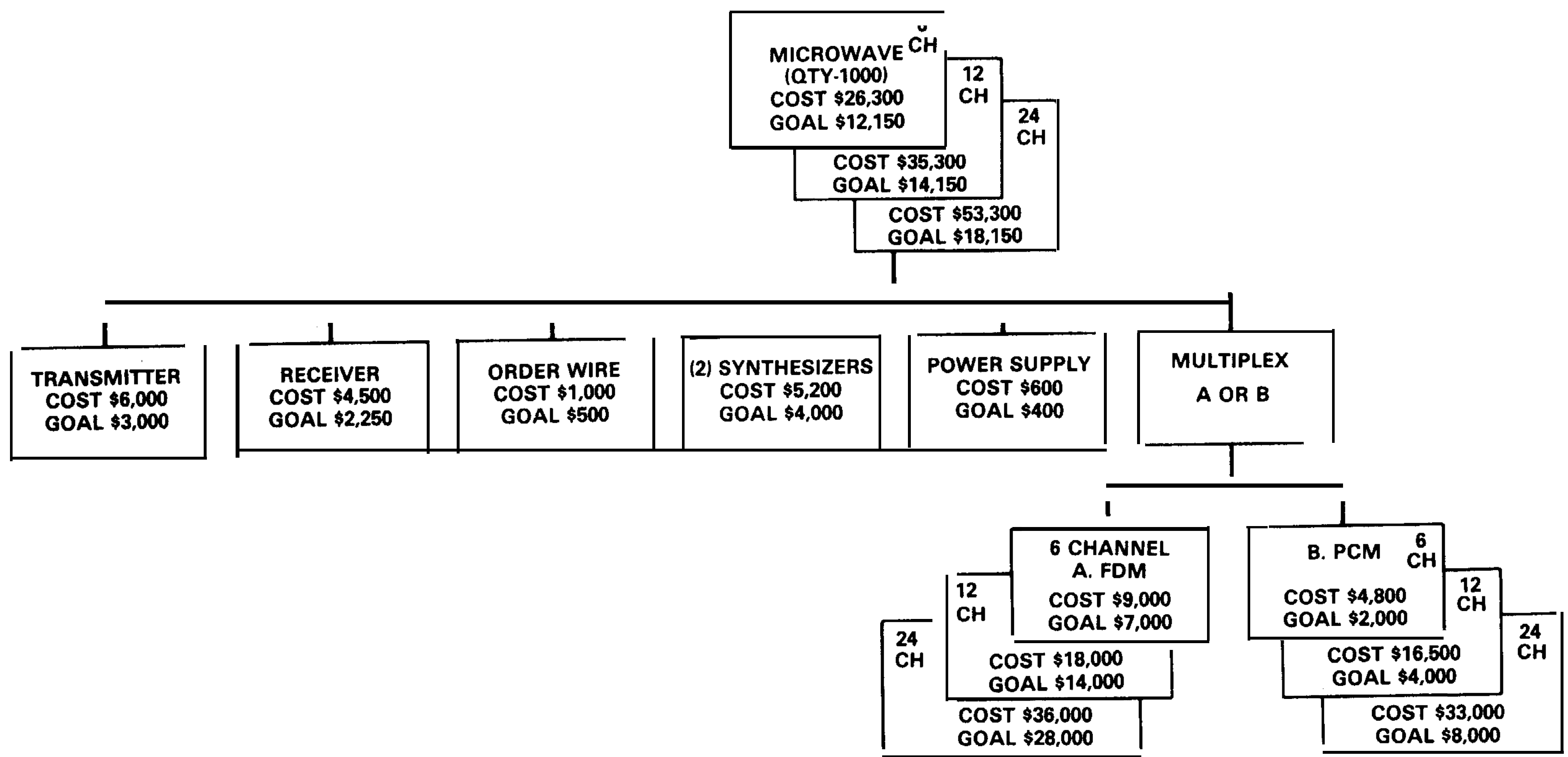

FIGURE V-3

suggesting corrective management actions to overcome such deficiencies as insufficient resources applied, unexplored opportunities due to lack of time, resistance to change, etc.

D. Cost Analysis

The first step in a cost analysis is to determine the total cost of an item. There have been cases where the simple act of determining costs has suggested the means and stimulated the necessary action to reduce them. However, the more usual approach is to divide the total cost into successively lower levels of cost indenture to facilitate analysis according to specific cost bases. The most frequently used bases are as follows:

1. Cost elements. The total cost is separated into its constituent elements such as labor, materials, purchased items, overhead, etc. Labor costs are further broken down into set-up and run costs. These cost elements are then compared to the total and to one another, and sometimes to corresponding elements for something similar. The purpose is to identify costs which appear to be excessive.

2. Cost increments. Careful examination of the incremental costs of processing something often uncovers an opportunity for further analysis. Often a large increment of cost is required to provide a small additional margin of performance or benefit. This marginal analysis can be used to identfy possible overspecification.

3. Cost per pound. Comparison of the cost per pound of like items at similar stages of completion may provide hints for areas to be studied.

4. Cost per dimension. Items such as cable, wire, tanks, and honeycombed sheets are usually described by dimension rather than by weight. cost per length, per area, or per volume are standard measures by which many things are bought. Cost per dimension of similar things can be compared for the purpose of suggesting alternatives.

5. Cost per property.' Comparative analyses of costs per specific property often reveal high-cost areas and suggest lower-cost alternatives. For example, the cost for a given conductance in aluminum compared to the cost for the same conductance in copper may lead to a cost reduction by changing from one material to another.

Speculation Phase

The purpose of this phase is to formulate alternative ways of accomplishing the essential functions. This effort begins upon completion of the orientation and information phases and the existence of function, cost and worth determinations. Four of the techniques used to help answer the question, "What else will do?" are:

o Simple Comparison - A thorough search for other things which have at least one significant characteristic similar to the subject of the study.

- Comparison of Function - A creative session in which new or unusual contributions of known things or processes are combined and rearranged to provide different ways of achieving the function.

- Scientific Factors - A search for other scientific disciplines capable of performing the same basic function. This involves contributions from specialists in disciplines not utilized in the original design. An industry specializing in some unique technique often can make a substantial contribution when called upon for assistance. For example, a cast motor support housing may be replaced by a welded wire form with a totally different material and configuration or hybrid circuits may be replaced by large scale integrated ones.

- Blast, Create, and Refine - Blast to get off the beaten path. Create by reaching for an unusual idea, for another approach. Refine by strengthening and expanding ideas which suggest a different way to perform the function.

Creative problem-solving techniques are used to discover alternatives that will provide essential function at the lowest possible cost. The-re are several formal idea-stimulation exercises that may be used during this phase of the VE study. All seek a great number of ideas. The greater the number of ideas conceived, the more likely that among them will be something that will eventually lead to better value. Judgment as to the practicality of an idea is deferred to a later stage. Departure from ordinary patterns, typical solutions, and habitual methods is encouraged, because it may be the new, fresh, radically different approach that leads to a better value solution.

Creativity is the development of ideas new to the individual. Idea stimulation techniques encourage the generation of creative solutions. Everyone possesses some degree of innate creative ability which can be improved through training and practice. The application of creative techniques to problem solving follows a step-by-step sequence. Innovation or creation is not always the result of conscious, or even logical, effort. However, this discussion will be confined to some of the typical ideation exercises undertaken during a VE effort[6] The ground rules for creative idea generation may be summarized as follows:

- Do not attempt to generate new ideas and to judge them at the same time. Separate these aspects by time, by place, and by different personnel if possible.

- Generate a large quantity of possible solutions. Multiply the number of ideas produced in the first rush of thinking by 5 or by 10, to set a goal for the desired quantity.

- Seek a wide variety of solutions that represent a broad spectrum of attacks upon the problem.

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[6] Department of Defense Joint Course Book, Principles and Applications of Value Engineering, Army Management Engineering Training Agency, Rock Island, Illnois 61201, Page 2-5.

- Watch for opportunities to combine or improve ideas as they are generated.

- Before closing the book on possible solutions, allow time for subconscious reflection on the problem.

There are two general categories of creative techniques used during VE efforts. The first is free association techniques. Examples of free association techniques are:

- Brainstorming[7] - a problem-solving conference method that is based upon the stimulation of one person's mind by another's idea. An average brainstorming session consists of a group of people spontaneously producing ideas designed to solve a particular problem. During this session, no attempt whatsoever is made to judge or evaluate the ideas. Evaluation and development of the ideas into practical solutions takes place after the brainstorming session has ended.

- Synectics[8] - a problem-solving technique that permits a diverse group to gain unusual and unique insights through the use of the metaphor. Specific psychological mechanisms are employed to develop unusual analogies to a specific problem. Development of these analogies subsequently leads to new and novel solutions.

The second category is organized techniques. A logical step-by-step approach is followed to generate ideas, one or more of which may provide the solution to the problem at hand. These organized techniques are:

- Checklist - an accumulation of idea clues, useful for the subject under consideration. The objective is to obtain a number of ideas for further follow-up and development. The checklist is a common aid in the search for new ideas. Checklists range in type from the specialized to the extremely generalized. Figure V-4 (page 5-18) is an example of a specialized checklist used in VE. Although checklists may aid in the development of new ideas and remind the user of essential steps in a particular process, they may also restrict thinking.

- Attribute Listing - the first step is to list all of the various characteristics of an object. The second step is to change or modify these characteristics. Using this technique, new combinations of characteristics (attributes) may be brought together which will better fufill some existing need. As an example, consider one type' of wooden-handle screw-driver which was common a few years ago. Each attribute could be changed as follows:

    Round shank changed to hex shank so wrench could be used to increase torque.

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[7] Osborn, Alex, Applied Imagination, Charles Scribners and Sons, New York, New York, 1963.
[8] Gordon William J. J., Synectics, Harper & Brothers, New York, New York, 1961.

Wooden handle replaced by molded plastic handle to cut down breakage and danger from electric shock.

End modified to fit all kinds of screws.

Push, pneumatic, or electric power.

Analysis Phase

The purpose of this step is to select for further analysis and refinement the most promising of the alternatives generated during the speculation phase. During speculation, there is a conscious effort to defer judgement so that the creative process would not be inhibited. During the analysis phase the ideas are subjected to a preliminary screening to identify those which satisfy the following criteria:

- Will the idea work?
- Is it less costly than the present design?
- Is it feasible to implement?
- Will it satisfy the user's needs?
- If the answer to any of the above is “no”, can the idea be modified or combined with another to give a “yes” answer?

The ideas which survive the initial screening are then rated according to their relative ability to satisfy the above criteria and their advantages and disadvantages are also noted. Preliminary cost estimates are then developed for those ideas which appear technically and economically most promising. These preliminary cost estimates are based on the same quantities as were the costs for the present design. Likely implementation costs and the impact on total ownership costs are also considered. Following these preliminary estimates, one or more of the ideas with significant savings potential are selected for further detailed analysis. However, if relative cost differences among several alternatives are not decisive at this point, they all may be analyzed further.

Development Phase

In this phase, the alternatives which have survived the selection process are developed into firm recommendations, called VEPs. This portion of the effort includes developing detailed technical and economic data. The proposal should include not only a before and after, but also its implementation plan and the anticipated impact on logistics aspects and total costs. This phase is also devoted to assuring that the VEP satisfies all of the user’s needs. For hardware projects a checklist such as the following is often helpful:

- Performance requirements.
- Quality requirements.
- Reliability requirements.

- System compatibility.
- Safety requirements.
- Maintenance considerations.
- Logistics support evaluation.

The VEP should include a discussion satisfying any objections likely to be raised concerning any aspect of the proposal. Conferences with specialists are often most helpful in overcoming anticipated objections in advance. If a technical characteristic of an alternative is either unacceptable or marginal, the alternative is modified to correct the deficiency, whenever possible. If it is not possible to overcome the deficiency, another alternative is selected for development. Of the technically feasible alternatives remaining, the lowest-cost one is selected for the detailed development of technical and economic data. In the event that more than one alternative appears to offer equivalent savings potential, the details of each continue to be developed.

In some instances proof of the technical acceptability of a concept can only be demonstrated by extensive testing Such extensive testing is not usually a part of the 'typical VE effort. However, limited tests are occasionally conducted to demonstrate the feasibility of a concept. This phase also includes determining the type, probable duration, and cost of any test program which may ultimately be required to prove the acceptability of a proposed alternative.

The completed proposal should include an accurate description of the changes as well as the cost impact and savings potential. Cost estimates should be of sufficient accuracy to assure the validity of the savings potential calculation.' The proposal must indicate that the proposed savings will be greater than the cost to implement it. All costs involved in making a change must be included. In some cases, such as a contractor-originated VECP submitted to the DoD both the originator and the responding agency may incur costs if the proposal is implemented. For the originating organization, these costs may include:

- New tools, jigs, or fixtures.
- Additional materials.
- New assembly instructions.
- Changes to plant layouts and assembly methods.
- Revisions to test and/or inspection procedures.
- Restraining assembly, test, or inspection personnel.
- Re-working parts or assemblies to make them compatible with the new design.
- Cost of tests for feasibility.

Other costs not normally incurred by the originating activity but which should be considered include:

- Technical and economic evaluation of proposals by cognizant personnel.
- Prototypes.
- Testing the proposed change including laboratory, firing range, and missile-range charges.
- Additional GFE which must be provided.
- If applicable, retrofit kits (used to change design of equipment already in field use).
- Installation and testing of retrofit kits.
- Changes to engineering drawings and manuals.
- Training Government personnel to operate and maintain the new item.
- Obtaining new and deleting obsolete Federal stock numbers.
- "Paper work" associated with adding or subtracting items from the Government supply system.
- Maintaining new parts inventory in the supply system (warehousing).
- Purging the supply system of parts made obsolete by the change.
- Changing the contract work statements and specifications to permit implementation of the proposal.

It is not always possible to determine the precise cost to the Government of certain elements of a change. For example, it is difficult to obtain the actual cost of revising, printing, and issuing a page of a maintenance manual. Nevertheless, this is a recognized item of cost, because the manual must be changed if the configuration of the item is changed. It is common practice to utilize a schedule of surcharges to cover areas of cost which defy precise determination. Such a schedule is usually based on the average of data obtained from various sources.

The final cost estimate should be compared with the functional worth determined during the information phase. If the difference insignificant, it may be desirable to continue the VE effort to develop further value improvements.

If more than one alternative offers a valid savings potential, it is common to recommend all of them. One becomes the primary recommendation and the others are alternative recommendations usually presented in decreasing order of savings potential.

Summary

VE utilizes a number of techniques which are specifically designed to assist in the identification of value problems, the generation of ideas which suggest solutions, the analysis of these for feasibility, and finally the development of practical solutions. There is no specific combination of these techniques which may be prescribed for all VE effort, nor is there a predetermined degree to which each is utilized. The selection of specific techniques and the depth to which they are used is primarily a matter of judgment and varies according to the complexity of the subject under study.

The VE Job Plan is the framework upon which a successful VE effort is built. When utilized in its entirety and in proper sequence, it assures a systematic approach to the identification and capture of a value opportunity. The VE Job Plan first provides for a thorough understanding of the subject under study, including a quantitative identification of the nature and worth of its functional requirements. Uninhibited creative effort is then applied to suggest alternative approaches to achieve all functions needed by the user. A series of evaluations then selects and develops the alternative offering the best opportunity for value improvement.

VALUE ENGINEERING CHECKLIST

Specification Review

(1) Have the customer's specifications been critically examined to see whether they ask for more than is needed?
"(2) Has the cost of any excessive design features been defined for its effect on production as well as on the R&D program?
(3) Has the cost effect of contract-required excessive specifications been discussed with the customer?
(4) Has the customer identified the target cost for each basic specification?
(5) What subassemblies have been designed in the early model to represent anticipated new devices that are intended to be used in eventual production?
(6) Where is the written description of the logic' supporting the design and its anticipated producibility?
(7) Have the significant "functions" necessary for essential performance been defined (a verb and a noun)?
(8) Do the reasons for any failures to acheive test, schedule, quality or pricing goals represent technology limitations and require a reexamination of the original objectives?"

General Design

(1) Does the design give the customer what he requires and no more?
(2) Could costs be radically reduced by a reduction of performance, reliability, and/or maintainability to the minimum specified?
(3) Could cost be radically reduced by a reduction of resistance to high temperature, shock, vibration, or other environments to the minimum specified?
(4) Have circumstances changed (changes in concept or specifications, progress in the art, development of new components or processes) so that the design include unnecessary or expensive circuitry parts or processes?
(5) Have unnecessarily high-cost items been included as a result of their availability when the breadboard or model was constructed?
(6) Can any variable devices such as potentiometers included for breadboard or model-operational-adjustment be changed now to fixed component parts or semi-adjustable design?
(7) Are proposed cost savings for this VE change still valid when analyzed over the systems life cycle?
(8) Does a failure modes and effects analysis (FMEA) substantiate this improvement?

Production Cost

(1) Are the quantities to be built on this order known? Are the estimated quantities to be built on future orders known? Have these factors been considered in the design decisions?
(2) Will tooling costs be in line with present and anticipated production?
(3) What is the estimated cost of the design in production?

Figure V-4

Electronic Design

(1) Does the design represent optimum electrical simplicity?
(2) Is circuitry overly complex or conservative?
(3) Have standard "preferred circuits" been reviewed to see how many can be used beneficially?
(4) Has the field of commercially available packaged circuits, power supplies, etc. been reviewed against requirements?
(5) Can circuitry be eliminated by having one circuit do the job of two or more?
(6) When specifying special component parts, have potential vendors been consulted for alternatives or modifications that would hold costs down?
(7) Have all high-cost components such as transistors, semiconductor diode magnetic and high-power devices, motors, gear trains and decoders been examined to determine whether lower-cost substitutions can be made?
(8) Are the components the lowest cost meeting the design requirement?
(9) Can any electrical tolerance be liberalized to allow specification of lower-cost parts?
(10) Have nearly identical parts been made identical to gain the advantage of quantity buying or manufacture?
(11) Does the selected circuitry exploit the latest advances in integrated circuit design and production?

Mechanical Design

(1) Does the design represent optimum mechanical simplicity?
(2) Is every part absolutely necessary? Can any part be eliminated or combined with another part to reduce total number of parts and cost?
(3) When specifying special parts, have potential vendors been consulted for alternatives or modifications that would hold costs down?
(4) Are mechanical tolerances within the limits of normal shop practice?
(5) Are the surface finishes the coarsest that will do the job?
(6) Are the fabrication processes the lowest cost meeting the design requirements?
(7) Have nearly identical parts been made identical to gain the advantage of quantity buying or manufacture?
(8) Are the materials the lowest cost meeting the design requirements?
(9) Does the combination of material and protective finish specified result in the lowest-cost combination?
(10) Has relative workability of materials been considered?
(11) Have standard alloys, grades, and sizes of stock been specified whenever possible?
(12) Can the designbe altered in any respect to avoid the use of nonstandard tooling?
(13) Does the layout for sheet-metal parts permit direct conversion to automatic sheet-metal machinery?
(14) Can the designbe modified to use the same tooling for right and left hand or similar parts?
(15) Are drawings for fabrication of parts that are similar to parts already produced cross-referenced so available tooling can be used?
(16) Can the design be altered to avoid unnecessary handling and processing resulting from such things as riveting and spot welding on the same subassembly part?

Figure V-4 (continued)

(17) Does CAD expression permit direct conversion to CAM?
(18) Are casting bosses of adequate size, considering the large tolerance in casting dimensions?
(19) Do standard drawing practices proposed by developer lead to optimum statistical fit?
(20) Is impregnation of castings called out when it would aid processing? (Castings should be impregnated after machining if they are to be electroplated. This impregnation prevents absorption of plating acids or salts. Castings should also be impregnated if they are to hold liquids or gases under pressure.)
(21) Have engineering and factory specialists been consulted for castings, forgings, weldments, heat treatment, and other specialties?
(22) Have standard sizes, grades, and alloys of fasteners been specified whenever possible?
(23) Are all manual welding operations specified absolutely necessary? Can furnace brazing be substituted?
(24) Are the assembly processes the lowest cost meeting the design requirements?
(25) Has adequate clearance between parts been provided to allow for easy assembly? (Parts have become smaller but hands have not.)
(26) Are markings adequate to guide the assembly processes?
(27) Have the engineering and factory specialists been consulted on any unusual assembly problems?
(28) Has datum-line rather than multiple-surface dimensioning been used on all drawings?
(29) Can any four-place dimension be changed to a three-place dimension?
(30) Can any three-place dimension be changed to a two-place dimension?
(31) Can heat treating after forming sheet-metal parts be eliminated by change of design or material to avoid straightening problems?
(32) Is all masking from finishing materials (such as plating solutions and paint) necessary?
(33) Have the parts been segregated into machine families for efficient fabrication?

Standardization

(1) Has the design been coordinated with similar designs, circuits, parts, or components to get optimum benefit from standardization and past experience?
(2) Are the standard circuits, standard components and standard hardware the lowest-cost standards which will supply the minimum-required characteristics?
(3) Can the use of each nonstandard part of circuit be adequately justified?
(4) Can any new nonstandard part be replaced by a nonstandard part which has already been approved?
(5) Do control drawings leave no question that a vendor standard part is being specified when such is intended?
(6) Has standardization been carried too far so the cost of excess function is greater than the gains resulting from high quantity?

Maintainability .

(1) Is each assembly’ self-supporting in the desirable position or positions for easy maintenance?

Figure V-4 (continued)

(2) Can assemblies be laid on a bench in any position without damaging components ?
(3) Can the assembly be repaired using available tools and test equipment?
(4) Has the cost of changes to technical manuals and drawings been evaluated?
(5) Can the assembly now be repaired at the next maintenance level?
(6) Has the built-in-test (BIT) capability been optimized?
(7) Have maintenance practices, procedure and equipment received adequate attention during product design?

Testing

(1) Are the test processes the lowest cost meeting the design requirements?
(2) Can any test specification be eliminated or relaxed?
(3) Have interacting controls been eliminated or the adjustments specified in such a manner that the lowest-cost factory-test personnel can easily align the circuit?
(4) Is the system compatible with the requirements for checkout in the factory -- if not as a complete system, then in large subsystem segments?
(5) Have the test-process experts been consulted for alternatives that would keep their costs down?

Subcontract

(1) Has the field of commercially available packaged units, sub-assemblies, and circuits been thoroughly reviewed to be sure there are no standard vendor items that will do the job?
(2) Is desired cost control adequately emphasized in subcontract specification?
(3) Have specifications for subcontract items been reviewed against the check list to be sure they are not overspecified?
(4) Have suggestions been invited from prospective suppliers regarding possible value improvements?

Figure V-4 (continued)